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THE EMBRYOLOGICAL DEVELOPMENT OF THE SKELETON OF THE HEAD OF BLATTA.

BY

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Thesis presented to the Faculty of Cornell University for the degree of Doctor of Philosophy.

Reprinted from THE AMERICAN NATURALIST, Vol. XXXVIII, Nos. 455-456.

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The Athenæum Press

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AMERICAN NATURALIST.

VOL. XXXVIII. *November–December, 1904.* NOS. 455–456.

THE EMBRYOLOGICAL DEVELOPMENT OF THE SKELETON OF THE HEAD OF BLATTA.[1]

WILLIAM A. RILEY.

OUR knowledge of the embryological development of the sclerites of the head of insects is very meager. With but few exceptions the subject has been treated in the most incidental manner and the observations are few and scattered. This is due not only to the fact that attention has been directed to the more general features of insect embryology, but is due also to a lack of systematizing of our knowledge of the structure of the head of the adult insect and to the difficulty of determining the limits of the sclerites before they become firmly chitinized.

Of all the students of insect embryology, Heymons ('95 and '97), Janet ('99), and Comstock and Kochi, (:02), are the ones who have devoted the most attention to this subject and these workers differ radically in their conclusions.

It was in hopes of determining the conditions in one of the more generalized of the pterygote insects that I undertook the study of the embryological development of the skeleton of the

[1]Contribution from the Entomological Laboratory of Cornell University.

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head of *Blatta germanica*. This was proposed by Prof. Comstock and to him I am indebted for many suggestions.

In the choice of an object for this study I was guided by the desire to select one of the more generalized forms and one which at the same time would afford an abundance of material. Both of these conditions seemed to be met by *Blatta germanica*. Though undoubtedly highly specialized in some respects, the cockroach is regarded by many students as the most primitive of our pterygote insects. I believe that in this respect one of the Plecoptera would have been more valuable, but as regards abundance of available material it would be difficult to select a form more satisfactory than is Blatta.

On the other hand, as objects of study the embryo of Blatta present certain difficulties which are accentuated in the course of the work. Of these there are "die ausserordentlichen technischen Schwierigkeiten" which Cholodkowsky has so emphasized. These are due primarily to the great mass of yolk, which becomes so brittle as to make it almost impossible to secure complete series of sections by ordinary methods. A more serious difficulty in the work under consideration was the small size of the cells and the indistinctness of the invaginations of the body wall. Of the latter, Wheeler ('89, p. 349) says: "In *Blatta* the formation of the nervous system in its earlier stages cannot be clearly seen from the exterior. The same holds true of the small tracheal invaginations, though several pairs, especially those of the thorax and basal abdominal rings, may be seen on the pluræ in good preparations before revolution. Still they are so much less distinct than in *Doryphora* that I have given them little attention."

The Primitive Segments of the Head.

The question of the number of segments in the body of the perfect insect early attracted the attention of entomotomists. As the history of the development of our knowledge of the number entering into the structure of the head has been very fully discussed by Comstock and Kochi (:02), I have but little to add to their account.

As early as 1839, Newport discussed this question in considerable detail. He believed in the "correctness of the opinions advanced by Savigny and others, that the organs of manduction are the properly articulated members of distinct segments and are perfectly analogous to the proper organs of locomotion." He attributed the conflict of views to a "too exclusive examination of the head in perfect insects, without reference to the corresponding parts in the larva."

It was thus early realized that it is to the ontogenetic record that we must appeal for a settlement of the question. Unfortunately Newport chose as the basis of his study the larva of *Musca vomitoria*, a form so highly specialized as to be worthless for this purpose. His evidence regarding the possible presence of a fifth segment must therefore be rejected. The value of his conclusion that there were at least four segments was due to his acceptance of the criterion proposed by Savigny.

Zaddach ('54), believed that six segments entered into the composition of the head. Of these the first was the ocular, while the third was the second antennal segment. His evidence regarding the presence of the latter, however, was based upon the erroneous conclusion that in the phryganids the larval antennæ represented the second pair of the Crustacea, and that they were later replaced by the definitive antennæ of the adult, which corresponded to the antennules of the Crustacea.

In 1858 Huxley also discussed the mooted question from the view point of embryology. With characteristic thoroughness and penetration he not only treated of the embryology of an insect, Aphis, but compared its development with that of Crustacea and Arachnida. Granting that the presence of paired appendages was indicative of an equal number of segments, he argues that the absence of the appendages does not necessarily imply the absence of the segment. "No one will pretend that it is so in the abdominal and thoracic regions." In conclusion he proposes the hypothesis "that in the Articulata the head is normally composed of six somites, which are all fully developed only in Podopthalmia, Stomapoda, and some Branchiopoda, while in other Crustacea some one or more of the preoral somites is more or less abortive, and in Arachnida and Insecta the

appendages of the first somite are sessile and those of the second or third undeveloped."

I shall have occasion to revert to this paper of Huxley's, for, as we shall see, he devoted considerable attention to a consideration of the development of the head, and brought out some facts of prime importance.

Packard ('66), believed that the insectean head was composed of seven segments. In 1870, in the second edition of the *Guide to the Study of Insects*, he gives a table of these segments and their appendages. He believed the segments to be a *first ocellary*, *second ocellary*, *opthalmic*, *antennary*, *mandibular*, *first maxillary*, and a *second maxillary* or *labial*. In addition to these seven he includes a hypothetical first segment whose tergal parts give rise to the labrum, epipharynx, and clypeus.[1] Thus at this time he regarded the insectean head as composed of eight primary segments.

In 1871, however, Packard presents evidence to show that the ocelli and the compound eyes do not represent appendages. "Accordingly," he says, "we seem forced to the belief that the head of the hexapodous insect consists of but four segments, *i. e.*, the second maxillary, the first maxillary, and mandibular segments behind the mouth opening and the antennary, or first and preoral segment situated in front of the mouth." This view he reiterates in 1883. In 1898 he tabulates six segments.

One of the most recent workers to approach this subject is Janet ('99). Basing his conclusions largely on a study of the musculature of the adult Vespa, this worker states that the so-called primary head segment — the protocerebral segment of authors — is in reality composed of four segments and that therefore the head of an insect is made up of not less than *nine* segments, all of which were primitively postoral. According to Janet these segments are:

1°	Le somite du gésier	ou	somite proto-stomodæal
2°	Le somite œsophagien	ou	somite deuto-stomodæal
3°	Le somite clypéo-pharyngien	ou	somite trito-stomodæal

[1] "The tergal parts (*i. e.*, the labrum, epipharynx, and clypeus) situated in front of the ocelli, are left out in enumerating the seven segments as they are not supposed by the author to belong to either of those segments." *L. c.* p. 20.

4° Le somite du labre	ou	somite proto-cérébral
5° Le somite antennaire	ou	somite deuto-cérébral
6° Le somite post-antennaire	ou	somite trito-cérébral
7° Le somite mandibulaire	ou	somite proto-gnathal
8° Le somite maxillaire	ou	somite deuto-gnathal
9° Le somite labial	ou	somite trito-gnathal

From the embryological view point Janet sees support for these conclusions in the development of the sympathetic nervous system. He considers "the nervous system of the stomodæum (or the unpaired sympathetic system) as being simply the morphological prolongation on the ectodermic stomodæal invagination, of the chain of the central system." The untenability of this view has been pointed out by Heymons, (:00), who has devoted especial attention to the study of the development of the sympathetic system, and whose argument, therefore, carries especial weight.

Of the work of Patten, Wheeler, Viallanes and Folsom, the excellent résumé by Comstock and Kochi leaves little to be said. These last writers accept Folsom's conclusion as to the presence of seven primitive segments, and agree with him that the appendages of the superlingual segment may be represented in the Orthoptera by a pair of small sclerites lying behind the lingua, within the mouth cavity. Neither Heymons nor Wheeler[1] accept this view. As regards the condition in the cockroach, I have only the negative evidence that there is wholly lacking a trace of a ganglion belonging to this segment. The position of the above mentioned sclerites is such as to make them readily susceptible of explanation on purely mechanical grounds, as secondary structures. Though Folsom's work was done on Anurida, and his corroborative evidence was drawn from a study of other Collembola, it is not to be expected that we should find such a fundamental difference between the Apterygota and the Pterygota.

[1] In a forthcoming paper, which Dr. Wheeler has kindly allowed me to anticipate by the above statement, he very fully and conclusively presents the arguments against such a view.

THE GENERAL FEATURES OF THE FORMATION OF THE HEAD OF BLATTA.

The changes during the first six days[1] of the embryonic life of Blatta lead to the formation of the ventral plate, the blastodermic thickening which represents the first rudiment of the germ band. This extends along about two-thirds of the ventral surface of the egg, beginning at about one-fourth of the length of the egg from its cephalic end.

The newly formed germ band is not an evenly developed structure, but there are to be seen, on each side, groups of rapidly proliferating cells. These active cells give rise to an indistinct segmentation in the earlier stages of the germ band. This was noted by Cholodkowsky ('89), who says, (p. 91): "However, when I say that the young germ band of Blatta gives no indication of cross divisions I do not mean by that that there are no traces of metamerism. Very early when the germ band is still very imperfectly marked off from the surrounding undifferentiated blastoderm, one may observe a noteworthy grouping of its cells around certain points which are none other than the centers for the formation of the future appendages."

Heymons ('95), has correctly interpreted this description of Cholodkowsky's as referring to certain formative centers in the undifferentiated blastoderm, which by their extension and fusion give rise to the germ band. A similar method of formation of the germ band of Astacus had already been pointed out by Reichenbach ('86). That Cholodkowsky was not clear as to the nature of these centers is evident not only from his reference to them as the precursors of the appendages, but also from his Figure 2, which shows an embryo of about ten days, in which the mouth parts and thoracic appendages are already prominent, while there is to be seen "die beginnende Gruppirung der Zellen für die Anlagen des ersten Paares von Abdominalfüssen."

[1] Cholodkowsky ('91), states that on account of the peculiarity of ovoposition, the age of the embryos of Blatta is not easily determined. As an illustration of this, I have found that there may be considerable variation in the degree of development of the embryos of a single capsule. However, the few observations I have made have, in the main, confirmed Wheeler's approximations, and I have followed him in determining the ages of the embryos studied.

An interesting fact is that, as pointed out by Heymons ('95b), the cephalic lobes arise from three pairs of these centers of proliferation, which very early fuse. Wheeler found that two such centers entered into the formation of the lobes of Xiphidium. The presence of the three pairs would preclude Cholodkowsky's idea that these centers represent future appendages. On first thought it might seem that their presence confirms Janet's view as to the compound nature of the preoral region. Janet believes, however, that there are three segments lying cephalad of the cephalic lobes, and that these do not fuse with the lobes, but in the later stages are invaginated with the stomodæum. It is evident that the formative centers of the cephalic lobes lend no support to that view. It has been suggested that they might represent the three segments whose ganglia enter into the formation of the brain. That this is not the case is shown from the fact that these areas precede the definite formation of the germ band, and that their fusion and consequent obliteration has taken place long before the deuto- and tritocerebral segments have united with the protocerebral segment.

It is during the seventh day, after the appearance of the blastoporic thickening of the caudal end, that there becomes prominent a pair of thickenings laterally placed at the cephalic end of the germ band (Fig. 1, *c. l.*). These thickenings represent the cephalic lobes, which are destined to play a most important rôle in the formation of the head capsule. From the first they are connected with the germ band. Of an independent development, such as described by Will ('88) for Aphis and by Heider ('89) for Hydrophilus, I find no indication in Blatta.

FIG. 1.—The germ band of seventh day. The cephalic lobes (*c. l.*) are indicated. × 120.

During the eighth day of embryonic life the most striking change is the appearance and very rapid development of the amnio-serosal folds,—phenomena which have been described in detail by Wheeler. The cephalic lobes develop rapidly, and during the first half of the ninth day they become prominently demarcated from the strap-like trunk region. The embryo in this stage covers about half of the ventral face of the egg, being somewhat

nearer to the cephalic than to the caudal end. In such an embryo, measuring 1.4 mm. in length, the lobes were .33 mm., about one-fourth of the entire length. Their breadth was .38 mm., compared with .24 mm. for that of the trunk region.

It is during this period that the antennæ appear. These, the earliest of the appendages, are in their origin post-oral. Though generally credited to Weismann, it was Zaddach ('54) who first pointed out this fact. Since that time many workers have confirmed the statement of Zaddach, but more recently it has been seriously questioned. Since the point is one of considerable importance in a determination of the origin of the sclerites, it is necessary to devote especial attention to it in this place.

Viallanes is especially pronounced in his opposition to the interpretation of the antennæ as originally post-oral. In '91, speaking of the 3rd stage in the development of Mantis, he says:

"Les antennes sont encore actuellement les seuls membres en voie de formation, elles apparaissent comme des mamelons à droite et à gauche de la bouche, mais non en arrière de celles-ci. Si au lieu de nous contenter d'examiner un embryon par transparence, nous l'examinons par réflexion, ce qui permet d'en apprécier bien plus exactement le relief, nous constaterons que les mamelons antennaires sont réunis l'un à l'autre par un bourrelet saillant passant en avant de la bouche. Ce bourrelet est fortement incurvé et sa concavité dirigée en arrière embrasse l'orifice buccal. Si nous supposions redressé ce bourrelet aux extrémités duquel se voient les mamelons antennaires, ceux-ci deviendraient nettement prébuccaux. Cette constatation ne nous donne-t-elle pas lieu de penser que les antennes, bien qu'elles apparaissent au niveau de la bouche (c'est-à-dire dans une région du corps qui ne peut être appelée ni prébuccale ni post-buccale), sont réellement prébuccales, bien que déviées de leur situation originelle par suite du développement excessif des lobes procéphaliques?" (p. 288.)

Later, concerning the 5th stage, he says: "Les mamelons antennaires ont grandi; par suite de l'accroissement des lobes procéphaliques ils sont rejetés en arrière et leur situation est devenue nettement post-buccale. C'est l'examen d'états ana-

logues à celui que nous décrivons maintenant qui a décidé la plupart des embryologistes à considérer, à tort croyons-nous, l'antenne comme un membre post-buccal." (p. 289.)

Viallanes was influenced in his interpretation by his studies of the nervous system of the adult, in which the deutocerebrum, the ganglion of the antennal segment, is clearly pre-oral, as is also its commissure.

More recently, Comstock and Kochi (: 02) have challenged the commonly accepted view. Believing that the clypeus "represents the median field of the sternite of the antennal segment," they argue that a study of the figures given by authors describing a post-oral position of these appendages "shows that while a line connecting the two antennæ would pass in some cases behind the mouth it is by no means so clear that the basal part of the rudiment of the antennal sclerite does not abut against the procephalon. In fact, the very figures given to support the view that the antennæ are post-oral in the early embryo support the opposite view." (p. 31.)

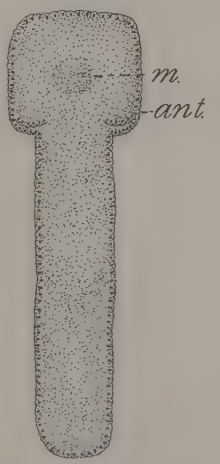

FIG. 2 — The ventral aspect of an embryo of about nine days. The antennæ (*ant.*) have just appeared, while the stomodæum (*m.*) is but indicated by a slight thickening of the cells. × 501.

A study of Blatta has served to confirm the view of Zaddach. At the time of the first appearance of the antennæ the stomodæal invagination has not yet manifested itself. Its position is marked, however, by an area of rapidly proliferating cells (Fig. 2, *m.*). The antennal rudiments are clearly caudad of this area, and are thus at their earliest appearance post-oral (Fig. 2, *ant.*). They increase rapidly in size, and at a stage but slightly later than that represented in Fig. 2, they lie caudo-laterad of the newly formed stomodæum. It is at this stage that they were studied by Viallanes. Very soon they are pushed more markedly post-orally, and it is in this stage that they have usually been figured (Fig. 3, *ant.*).

From the view point of comparative anatomy we have in Apus strong evidence of the original post-oral position of the antennæ.

Lankester thought that in this form the antennæ of the adult were innervated from subœsophageal ganglia. Though this has proven to be incorrect, Pelseneer ('85) has shown that the antennal ganglia of the adult, though associated with, are histologically perfectly distinct from those of the archicerebrum, and that they are perfectly homologous with the ganglia of the ventral cord.

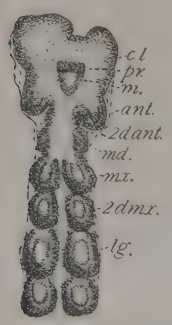

FIG. 3.— Embryo late in the tenth day. The antennæ lie laterad of the stomodæal opening. The procephalon (*pr.*) lies cephalad of the opening. Between the antennæ (*ant.*) and the mandibles (*md.*) lie the second antennæ (*2d ant.*). × 80.

By the end of the ninth day there are to be seen, in addition to the antennal rudiments, those of the thoracic appendages, which are distinctly outlined, while those of the mouth-parts are merely indicated. This is the stage figured by Wheeler ('89, Fig. 44). Wheeler found that in many embryos, as in the one which he figures, "one or, more rarely, both antennary lobes are temporarily bilobed." This he thought might be due to a temporary reversion, 'tending to show that the antennary lobes originally gave rise to two pairs of appendages which were perhaps homologous with the two pairs of antennæ in the Crustacea.' In embryos but slightly more advanced I, also, have seen indications of this bilobulation. Believing that the antennæ of insects are not to be homologized with those of the annelids but, rather, are homodynamous with the other appendages, I should regard this temporarily bilobed condition as a possible reversion toward a biramous condition of the appendage.

The next notable change is the appearance, during the tenth day, of the mouth and of the rudiment of the procephalon. The mouth is not invaginated from within the latter, but, as is shown by Figure 3, lies caudad of it.

There has been much discussion concerning the origin of this rudiment of the procephalon which, by many, is spoken of as merely that of the labrum. A number of observers have reported that in certain forms it originates as a paired structure (Hydrophilus, Kowalevsky, '71, Heider, '89, Graber, '90; *Bombyx mori*, Tichomiroff, '82; Pieris, Gastropacha, Zygæna, Graber,

'90; Hyalotoma, Graber, '90; Chalicodoma, Carrière, '90, Bürger, '97). Kowalevsky, Patten, Carrière, and others maintain that not only does this structure arise from paired rudiments, but that it represents a fused pair of appendages. Bürger in his edition of Carrière's notes, does not commit himself to the latter view.

On the other hand a greater number of species have been noted in which the procephalon is, from the first, unpaired. Among these are included a number of Apterygota (see Folsom, : 00, pp. 93–96), while of the Pterygota may be mentioned Aphis (Huxley, '58); Apis (Grassi, '84); Œcanthus (Ayers, '84); Forficula (Heymons, '95); Mantis (Viallanes, '91); Blatta (Cholodkowsky, '90); *et al.* Heymons has emphasized the fact that the place of origin of the labrum, *between* the two halves of the nervous system rather than laterad of them, fundamentally distinguishes this structure from the true appendages.

Especial attention was directed to this point in Blatta on account of finding an embryo in which the procephalon was quite clearly in two distinct halves. A study of a large number of other preparations of the same stage failed to duplicate this, though in some there was to be seen a slight mesal constriction. As the embryo first mentioned was otherwise distorted I am inclined to regard the appearance of the procephalon as abnormal, and to agree with Cholodkowsky that in Blatta its rudiment is unpaired.

By the end of the tenth day the embryo has increased considerably in length, and the mouth part appendages are all distinct. In an embryo of 1.5 mm. length, the ocular and antennal segments, which at this time constitute the head of the embryo, measured 275 μ, while the mouth part region was 350 μ in length, their relative extent being thus as 11 : 14. The 1st and 2nd maxillæ are subequal and have relatively the same situation upon the germ band. The mandibles are considerably smaller, but are equally distinct (Fig. 4).

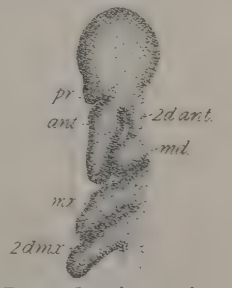

FIG. 4. — Lateral aspect of an embryo a little older than the preceding. × 80.

A striking feature of embryos of this period is the relation

of the mandibles to the antennæ. They are separated by a space much greater than that which separates the mandibles from the 1st maxillæ. This appearance, which in Hydrophilus proved so puzzling to Heider, is due to the presence of the so-called "intercalary," "Vorkiefer," "premandibular," or "tritocerebral" segment. As the evidence all tends to show that this segment is the homologue of the second antennal segment of the Crustacea, it should be designated either so or as the *tritocerebral* segment rather than by the indefinite and non-commital term "premandibular."

Wheeler ('93) was the first to demonstrate in Anurida a pair of vestigial appendages, which bear to its ganglion the same relation as do the other appendages to the ganglia of their respective segments. Wheeler's work has been abundantly confirmed by workers on the embryology of the Apterygota, Uzel ('98) and Folsom ('99) having determined that in certain forms these appendages persist even to the adult stage.

Though these results have been generally accepted as applying to the Apterygota, embryologists have been unwilling to accept the scant evidence of the presence of such vestigial appendages in the Pterygota. As long ago as 1870 Bütschli observed in the embryo of Apis a paired rudiment just behind the mouth, which, as he said, "sich fast wie ein Paar innerer Antennen ausnimmt." Bütschli himself did not regard this structure as homologous with the other appendages. Grassi ('84) also noted these appendages, but contrary to Bütschli, who thought that they fused to form a transitory under lip, Grassi states that they quickly disappear without leaving a trace. Moreover, he went farther than Bütschli in comparing them to antennæ, for, as Heider has pointed out, he says, "Il primo paio d'arti boccali, che ha un'esistenza effimera, può forse paragonarsi ad un paio d'antenne degli artrapode" (p. 57). Carrière ('90) described similar rudiments for Chalicodoma, and his statements were verified by Bürger ('97). On the whole, however, insect embryologists discard the above evidence and agree with Heymons ('95 b) who says of the tritocerebral segment, "Sein rudimentär Charakter gibt sich hauptsächlich darin zu erkennen, dass sich an ihm niemals Extremitäten entwickeln. Dies gibt wenigstens, so weit wir bisher wissen, von den pterygoten Insecten."

In the face of these opinions it may seem somewhat venturesome to assert that in Blatta there are evidences of the presence of such appendages. And yet, I believe that the facts warrant this conclusion. In embryos of the eleventh day, in favorable specimens there are to be seen between the antennal and the mandibular rudiments, in the region occupied by the tritocerebral ganglion, small but distinct thickenings of the hypodermis (Fig. 4, *2nd ant.*). Moreover, these are to be detected in both cross and longitudinal sections (Fig. 5), and bear to the ganglion of the tritocerebral segment the same relation which we should expect of appendages. To be sure, not every hypodermal thickening is to be interpreted as the rudiment of an appendage. Since, however, the thickenings under consideration occur not only in one but in several preparations, since they occur in the location we should expect for such appendages and do not occur between the other pairs of appendages, and since, lastly, they bear the expected relation to the ganglia of the second antennal segment, I see no other interpretation than that they represent vestiges of appendages such as are still developed in some of the apterygote insects.

FIG. 5. — Longisection of an embryo of eleven days. × 106.

The mouth-part appendages rapidly increase in size, and early in the eleventh day the length of the 1st maxillæ considerably exceeds that of the second maxillæ, while a little earlier these appendages were subequal. Measuring from the caudal angle to the apex, we find the length of the mandibles to be about 55 μ, that of the 1st maxillæ 96 μ, while the 2nd maxillæ are but 70 μ. There is no trace of lobulation in any of the mouth parts.

The procephalic rudiment has become prominent and, in the latter part of the eleventh day, appears as a button-shaped swelling overlying the mouth. In surface views the mouth can be seen through the rudiment, lying slightly caudad of its center. It is this appearance which has led to the incorrect statement that the mouth develops *in* the procephalon. In embryos of

this age it will be seen that the antennæ are migrating forward. They have increased in length so as to almost completely overlie the mandibles.

FIG. 6.— Embryo of about thirteen days showing antennal sclerites (*a. s.*) × 80.

The procephalon increases rapidly in size and pushes caudad over the mouth and between the antennæ. In many specimens there is to be noted a constriction of its caudal portion, while the mesal notch of the caudal margin is also distinct.

Early in the twelfth day are to be seen signs of the lobulation of the 1st and 2nd maxillæ. I find no indication of the lobes of these appendages arising from separate, isolated centers, as Heymons ('95a) has described.

It has been stated that the mandibles of Blatta are always simple. I was interested to find that in a few embryos of twelve to thirteen days they appear to be feebly trilobed. This agrees with the condition in Œcanthus, as described by Ayers (p. 24). Korotneff ('81) also represents the mandibles of Gryllotalpa as feebly trilobed (see his Fig. 6), though he says nothing about it in the text.

FIG. 7. —2nd maxilla of embryo of about thirteen days, showing lobulation. × 120.

Throughout the series it is evident that there is not a perfect fusion of the antennæ with the cephalic lobes, but the point of origin of these appendages is separated from the lobes by a constriction which demarcates a more or less definite area of attachment for the antennæ. This may be seen in Figure 6.

FIG. 8.—2nd maxillæ of an older embryo (about fifteen days) showing the mesad migration. × 120.

The lobulation of the 2nd maxillæ is well shown by Figure 7, which shows one of these appendages from an embryo about thirteen days old. Their mesad migration proceeds rather slowly, until during the fifteenth day they present the appear-

ance shown in Figure 8. They have not yet fused, but the future labrum is clearly outlined. In the meantime they have also migrated forward, so that the space which formerly separated them from the 1st maxillæ has been considerably reduced, and in lateral view the 2nd maxillæ are more or less hidden by the first pair.

About this time there appears a prominent invagination lying cephalo-mesad of the base of the mandible, close to the mandibular ganglion. This lies under the antennæ, but can be seen by focusing below that appendage or by removing it (Fig. 9, *a.t.*). In the same embryos there are prominent ten pairs of tracheal invaginations on the pluræ of the meso-, and metathorax and the first eight abdominal segments. For the prothorax there is a pair of slight and indistinct invaginations which have escaped the attention of previous workers on Blatta. It should be noted that the location of the above mentioned mandibular invaginations is in no wise comparable to that of the tracheæ. In addition to these invaginations there are in the mouth-part region three other pairs — one pair at the cephalo-lateral angle of the mandibles, one between the mandibles and the maxillæ, close to the caudo-lateral angle of the mandibles, and one cephalo-laterad of the base of the 2nd maxillæ. The last pair of invaginations is difficult to detect, for they are smaller, their lumen is not prominent and is frequently hidden by the caudal margin of the 1st maxillæ. It is shown in Figure 10, *p. t.* The invaginations lying laterad of the mandibles form tendons for the mandibular muscles. The rôle of the first and the last pairs in the formation of the tentorium or endoskeleton of the head will be discussed later.

FIG. 9. — Embryo of about fourteen days with right antenna removed, showing the location of the anterior tentorial invagination (*a. t.*) × 80.

Up to this period the length of the mouth-part region has considerably exceeded that of the combined ocular and antennal segments. Thus, as we have seen, in an embryo of about eleven

days the latter region measured 275 μ in length as compared with 350 μ for the mouth-part region. In an embryo at the close of the twelfth day the antennæ have moved forward until the anterior section measures but 200 μ. The mouth-part region, owing to the loss of the tritocerebral segment and the reduction also taking place in the 2nd maxillary segment, measures 280 μ. A comparison early in the fourteenth day shows that the two regions are approximately equal in length. This, as we should suppose from the above, is due not so much to an increase in the size of the anterior region, as to a reduction of the mouth-part region, due to the cephalad migration of the mouth parts. The developing pronotum of the prothorax is pushing rapidly forward, and is limiting the pleural region of the maxillary segments (Fig. 10, *pn.*).

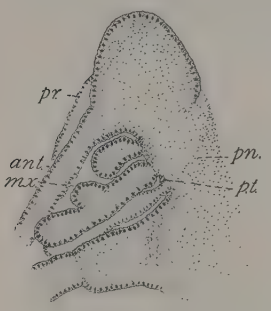

FIG. 10.— Embryo of about sixteen days, showing posterior tentorial invagination (*p. t.*) and the reduction of the mouthpart region. The pronotum (*pr.*) has pushed forward until its anterior margin lies over the first maxilla. × 53.

During the sixteenth day there occurs the series of changes which Wheeler ('89) has described as the revolution of the embryo. This is a period of very rapid growth, and at its close there has been completed the circumcrescence of the yolk by the embryo.

At about the beginning of the sixteenth day, just as these changes have commenced, the conditions do not differ markedly from what I have just described.

The reduction of the mouth-part region is rapidly progressing, the length of the anterior measuring 200 μ as compared with 160 μ for the mouth-part region. The pleural region of the prothorax has extended forward until its most cephalic point lies over the base of the 1st maxillæ, while its indistinct spiracular invagination lies over the base of the 2nd maxilla. The cephalic lobes have extended back until they lie well over the base of the mandibles. The 1st maxillæ greatly exceed the 2nd, which have all but fused to form the labium.

In ventral view of embryos about this age the appendages completely hide the sternal region; but on carefully dissecting

A NEW SPECIES OF DIAPTOMUS FROM MEXICO.

A. S. PEARSE.

Diaptomus lehmeri, n. sp.

Cephalothorax, broadest at the middle; with four distinct sutures. The last segment, produced laterally and armed with two prominent spines. The first segment of the abdomen, armed on each side with a strong sharp spine. The first segment of the female abdomen is tapering and about as long as the remainder of the abdomen. The second segment is short, being only one-fourth the length of the third. The furcal rami are almost twice as long as broad, and hairy on both margins in the female (Fig. 1), but on the inner margin only in the male.

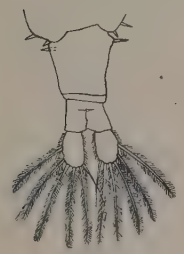

FIG. 1.—*Diaptomus lehmeri* n. sp. Abdomen of female × 87.

Antennæ twenty-five segmented and reaching beyond the tips of the furcal rami. The right male antenna (Fig. 4) is moderately swollen and its antepenultimate segment bears a pointed curved hook, which is not as long as the ultimate segment.

FIG. 2.—*Diaptomus lehmeri* n. sp. Fifth feet of male × 205.

The male fifth feet (Fig. 2) are rather robust. The first basal segment of the right foot has a tubercle near its outer margin which bears a long sharp spine. The second basal segment is almost as

broad as long and besides the usual hair on the outer margin it is provided with a characteristic process on its posterior surface. There is a small hyaline projection on the distal margin of this segment and also on that of the first segment of the outer ramus. The first segment of the outer ramus is very short, being one-third as long as the second segment and is produced into a tubercle at its outer distal angle. The second segment has a large tubercle on its posterior surface. The marginal spine is strong, but slightly curved, longer than the segment, two-thirds the length of the terminal hook, and is roughened on its inner margin. The terminal hook is strong, arcuate and minutely denticulate at the middle of its inner margin. The inner ramus is one segmented, short, (about as long as the first segment of the outer ramus) and hairy at the tip.

Fig. 3.—*Diaptomus lehmeri* n. sp. Fifth foot of female × 205.

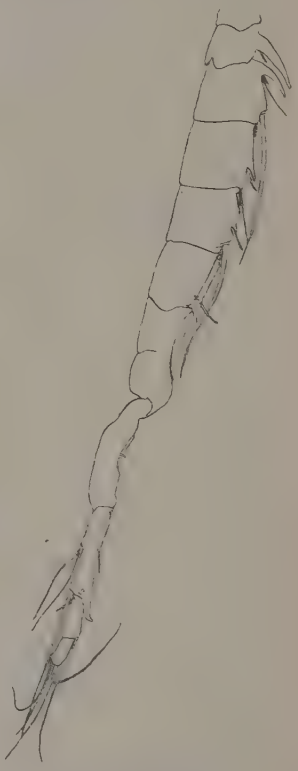

Fig. 4.—*Diaptomus lehmeri* n. sp. Tip of right antenna of male × 128.

In the left male fifth foot (Fig. 2) the first basal segment is armed with a tubercle and spine like that of the right. Second basal segment is three-fourths as broad as long and bears the usual hair on its outer margin. First segment of the outer ramus curved on outer margin, the inner margin notched and ciliated. The terminal segment is triangular and ends in a blunt process and proximad to this is a slender hair; the

inner surface is ciliated. The inner ramus is short and hairy at the tip.

The female fifth foot (Fig. 3) bears a large tapering spine at the outer distal angle of the first basal segment. The second basal segment is triangular and provided with the usual lateral hair. The outer ramus is three segmented. The first and second segments are about equal in length. The second segment is tapering and along the center of its inner side is armed with strong teeth and is usually with two or three small teeth on the outside. The second segment has a short spine above the third segment. The third segment is small and is armed with a long and a short spine. The inner ramus is not half as long as the first segment of the outer ramus and is two segmented. The second segment is armed with two terminal spines with delicate hairs between them and a lateral spine on the inner side.

Length: Female 1.69–1.83 *mm.* Male 1.61–1.67 *mm.*

The specimens from which this species is described were collected by Mrs. Frank Lehmer, July 22 to August 7, 1904, in Mexico City, Mexico. It was apparently abundant at that time, as it occurs in most of the dredgings made.

This species was associated with *Cyclops viridis insectus* Forbes, *Cyclops albidus* Jurine, Canthocamptus sp.?, and an ostracod.

HYLA ANDERSONII AND RANA VIRGATIPES AT LAKEHURST, NEW JERSEY.

WILLIAM T. DAVIS.

On the 5th of last September while looking for insects near a swamp at Lakehurst in the pine barrens of New Jersey, the writer was fortunate in finding a specimen of the rare tree frog *Hyla andersònii* Baird. The frog was in a small oak tree standing but a few feet from the swamp. At the time Cope's work on "The Batrachia of North America" was published in 1889, but three specimens had been recorded, namely the type from Anderson, South Carolina; the one collected at Jackson, Camden Co., New Jersey, in 1863 by Leidy, and the third example found by Dr. John E. Peters at May's Landing, Atlantic Co., New Jersey on June first, 1888. A record of this last is to be found in the *American Naturalist* for January, 1889. In the *American Naturalist* for December, 1894, J. P. Moore gives an account of two of these tree frogs collected in June, 1889, at Pleasant Mills, New Jersey, and of the many others heard at the time. The frogs, however, disappeared shortly and no others could be found on subsequent visits to the locality. Lakehurst is considerably farther North than the three New Jersey stations mentioned above. It may be well to mention at this time that *Rana virgatipes* Cope, is also to be found at Lakehurst. The species was originally described from Cape May County, New Jersey.

According to Cope, in *Hyla andersonii*, "The green of the back and extremities is everywhere margined with pure white, except posteriorly on the femur and tibia, and anteriorly on the former where saffron takes its place." My living specimen, however, differs from this description and the colored figure, by having the band of pure white extend along the end of the body and a short distance on the posterior margin of each femur.

New Brighton, Staten Island, N. Y.

NOTES AND LITERATURE.

PSYCHOLOGY.

Natural Science and Psychology.[1] — For the convenience of those who do not have access to his "Grundzüge der physiologischen Psychologie" Prof. Wundt has reprinted under the above title the last two chapters of the third volume of his great work. In the space of a hundred pages there is given a clear statement of what the author believes concerning: (1) The logical foundations of natural science, (2) Mechanics and energetics, (3) Mechanism and vitalism, (4) Causality and teleology of the psychophysical life-processes, (5) The concept of mind, (6) The principles of psychical causality.

Of special interest to biologists are the discussions of mechanics and energetics, and of the mechanistic and the vitalistic theories. Such a book is valuable to most natural sciences in that it serves to call attention to the too much neglected presuppositions on which specialistic work in the natural sciences rests, as well as to the principles of the sciences. Wundt writes in a patient, plodding, persistent manner; his sanity is all the more evident because of the lack of any brilliancy of treatment.

In view of the appearance of this reprint it is worth while to notice the interest, especially among the German biologists, in the psychic "as an elemental factor in nature," as Driesch in a recent book has stated it. Whether one agrees with Wundt's conception of the relations of the physical and the psychical, with Driesch's, with Ostwald's, with Schneider's may not seem of much consequence to most students of natural science; nevertheless, there can be no doubt that only those who hold theories and see or seek principles can do more than assemble facts whose meaning is clear only in the light of the generalizations which are called laws. No one can study Wundt's book without gaining an interest in the various forms of organic processes that the mere search for facts would not give. To state the content of the book would defeat my purpose to arouse an interest which may lead many to the work itself.

ROBERT M. YERKES.

[1] Wundt, Wilhelm. *Naturwissenchaft und Psychologie.* Leipzig, 1903, 8vo, 126 pp.

"The Criminal Classes."[1] — Rev. D. R. Miller, D.D., has been chaplain of the Ohio Penitentiary and superintendent of the Girls' Industrial Home of Ohio. In "The Criminal Classes. Causes and Cures" he has collected material of various sorts connected with his service in these positions.

At the beginning, near the middle, and near the end of the volume, are chapters briefly treating in a general way the extent of crime, its cost to the community, causes of crime, and methods for the prevention of crime. These discussions are somewhat vague and commonplace and are not fully adjusted to the results of recent scientific study. This sentence from the chapter on "Innate and Psychological Causes" may serve as an illustration of the nonagreement with conceptions of present day physiological psychology: "Regarding moral conduct, in this class there seem to be indications of a broken or missing link between the brain tissues and the moral monitor." There are evidences also of lack of familiarity on the part of the author with recent literature in penology. For instance, he writes, "As agencies in the prevention of crime and the reformation of young criminals, too much importance cannot well be attached to the private and public institutions denominated 'Child-saving institutions,' 'Schools for the little ones,' and 'Homes for children.'" He then fails to mention the movement now in force in many parts of this country, which recognizes that care for children in institutions has not generally prepared them well for life outside of institutions, and which substitutes for the institutional method the methods of probation and placing out, that is, the supervision of the rearing of delinquent and dependent children, while they live as members of their own or other families. Many of the figures on which arguments are based are given without dates but as taken from books and reports now many years old. On the whole these general chapters cannot be said to give an adequate summary of facts known and theories held to-day on the topics which they treat.

A few chapters offer meagre outlines of the careers of noted criminals. Others give brief accounts of the lives and crimes of Ohio convicts. "In the introduction, however," as Dr. Miller says in the preface, "of these narratives, sketches, and illustrations, special care has been exercised to avoid sensational details of the crimes alleged because it is the opinion of the author that all such details serve as

[1] Miller, D. R. *The Criminal Classes. Causes and Cures.* Dayton, United Brethren Publishing House, 1903. 8vo, ix + 227 pp., portraits.

factors to turn into like crime those who may read them." Some of these chapters close with reflections, which, it must be said are in part obvious, in part without special applicability to the cases to which they are attached.

About half the chapters of the book are devoted to incidents that occurred in the author's experience as chaplain, and to writings by prisoners, in prose and poetry, on religious and other topics, some apparently sincere, others with a suggestion of cant. In religious work for the prisoner results can doubtless be gotten easiest by appeals which recall religious instruction received during childhood. At the same time nothing in a man's work as chaplain forces him to adapt himself to changes in religious thought in the world at large. It is natural, therefore, that the weight of the religious interest of the author should be, as it is, such as belongs with religious beliefs of a conservative type.

There is an introduction by Ex-Governor Foster of Ohio. A chapter by Professor Krohn of the University of Illinois compares criminals in whom strange combinations of traits are found with cases of double personality, but fails to call attention to some important differences.

Apparently Dr. Miller is a man who has done earnest and helpful personal work with the criminals placed in his care, but who in his devotion to his own special task has failed to gain the broad acquaintance with current thought in criminology and related subjects which would be needed for writing a very useful book on the causes and cures of crime.

ZOÖLOGY.

Fixation of the Eggs of the Crab. — Dr. H. Charles Williamson, in the 22d *Annual Report of the Fishery Board of Scotland*, adds considerably to our knowledge of the life history of the shore crab of Europe, *Cancer pagurus*. Possibly the most interesting is his discovery of the way in which the eggs are fastened to the swimmerets. These, like other eggs, have double envelopes, the outer chorion and the delicate inner vitelline membrane, and between these a small perivitelline space. When the eggs are extruded from the oviducts they pass into the brood chamber between the abdomen and thorax

and here are held in position by the exopods of the swimmerets while the endopods, covered by slender filiform hairs, extend into the mass of eggs. The pleopoda have powers of motion in two planes, one fore and aft, the other oblique. By these motions the ends of the hairs are brought in contact with the eggs which are thus penetrated by them, the hair passing in and out again. The egg itself rotates and escapes injury. In this way numbers of eggs are impaled or skewered on each hair. As development proceeds the chorion stretches and gives rise to a stalk, which increases in length with time. This process is also aided by the perivitelline fluid, which is adhesive and sticks the chorion to the hair. After the egg is hatched the egg shells and their stalks are cast off by molting the integument, the outer layer of the hairs, together with the adhering shells being cast with the rest of the 'skin.' The eggs are fastened only to the hairs of the endopods, as these alone are smooth and filiform. The hairs of the exopods are plumose or serrate, a condition which prevents their perforating the eggs.

Gardiner's Maldives.[1] — The third part of the second volume of Gardiner's Report maintains the unusually high quality of its predecessors. It contains six papers, of which three are written by members of the expedition and the three others by well known specialists.

The Isopoda are treated by Stebbing in 23 pages. Thirteen species are described, representing eight families. While some are from the sea at moderate depths, two (a Corallana and a Limnoria) are found in rotten wood in the lagoon, one (Cirolana) lives in tentacles of a large tubicolous polychæte. A Cymothoa lives on the gills of a parrot-fish. Tylokepon, n.g., is a bopyrid living on the gills of crustacea. Finally, a sphæromid (Exosphæroma) and a Ligia are representatives of two semi-terrestrial groups.

The Hydromedusæ are treated by Browne. The discussion of the Anthomedusæ leads to a revision of the family Williadæ with two genera, Willia and Proboscidactyla, of which the latter only is in the collection from the Maldives. It occurs also on the east coast of North America and has several species notable for their production of medusa buds. Among the Leptomedusæ is a five-rayed representative of Mayer's genus Pseudoclytia which Browne, following Mayer, believes to have arisen as a sport. The Trachomedusæ are treated in synoptic fashion. A new species and a new

[1] Gardiner, G. S. *The Fauna and Geography of the Maldive and Laccadive Archipelagoes, etc.* Vol. II, part III, pp. 589-698, pls. 35-48.

genus are created. Hermaphroditism is described in one case. One Narcomedusa, a long known species of the Indian Ocean, is described. Five species of Siphonophores were collected. The author states that he could find no copy of the Mark Anniversary Volume in London. Let him apply to Henry Holt & Co., New York.

The reptant decapods of the suborders Hippidea, Thalassindea, and Scyllaridea, are treated by Borradaile. The first two groups are taken between tide marks, the latter in the reefs or on sandy bottom. There are enumerated two albunoids and three hippids (Remipes), one axiid, a gebiid, four callianassas, two palinurids and one Scyllarus.

The Madreporaria are treated by Gardiner, who lays especial stress on their variation, distinguishing vegetative, continuous, and discontinuous or specific. This extensive paper is accompanied by well executed half-tone plates from photographs of the dry corals.

The Antipatharia are described in a few pages by Forster Cooper. They are chiefly Indian Ocean species.

The Arachnida of the archipelagoes, treated by Pocock, raise the question of their origin. "Some of the species, such as Isometrus europæus, Heteropoda regia and Uloborus geniculatus, which frequent human dwellings, have doubtless been introduced by human agency; but it is probable that the ancestors of the majority of the Spiders reached these islands on floating gossamer threads." "The presence of only one species of Scorpion [Isometrus europæus], and that a form notoriously liable to dispersal by man's instrumentality, suggests that, unless in very remote times, there has been no connection between the archipelagoes and the mainland of India . . . . and this is further borne out by the almost complete specific identity between the two faunas."

C. B. D.

CLIMATOLOGY.

Ward's Translation of Hann's Climatology.[1] — Dr. Hann, professor of cosmical physics at the University of Vienna and formerly director of the Austrian Meteorological Bureau, published in 1883

[1] Hann, Dr. Justius. — *Handbook of Climatology. Part I, General Climatology.* Translated by Robert DeCourcy Ward. The Macmillan Company, 1903. 8vo, 437 pages.

his *Handbuch der Klimatologie* which he reissued in 1897 in three volumes. This is the standard work on the subject of climate and no book in the English language is so authoritative or covers so wide a field. Consequently, Professor Ward's translation of the volume relating to General Climatology, which was made primarily for the use of his classes at Harvard University, confers a great boom on all American and English students of meteorology and physical geography.

In his title, Professor Ward has been too modest, for his book is itself revised and enlarged, considerable new matter relating to America having been substituted for certain topics which pertained more particularly to Europe. While it might be wished that this new material were distinguished from the author's German text, it is stated that all the additions have been approved by Dr. Hann, so that the translation is virtually a third edition of this part of the original work. Numerous references to recent periodical and other literature, in various languages, have been added and all the old references have been verified, so far as possible, by the translator. An added convenience is the summary of the contents of each chapter, while a copious index of subjects and authors facilitates looking up either. The metric system and the Centigrade scale of temperature are used throughout and should aid in familiarizing our students with these units, which are destined to supplant the English system in scientific writings. At present, however, the conversion tables in the Appendix will, no doubt, be found necessary by many readers. The German text has been accurately rendered into elegant English, and almost no typographical or other errors have been noted. As was said, only the first volume of Dr. Hann's work has been translated and this evidently possesses the most general interest, since the climatology of special regions, discussed by Dr. Hann in his other two volumes and consisting largely of statistics, can be more easily consulted by persons not familiar with the German language.

In conclusion, the reviewer expresses the hope that this admirable and disinterested work may have a wide circulation in our high schools and colleges and indeed among all English speaking persons who desire to understand the climatic conditions of the globe and their cause.

A. LAWRENCE ROTCH.

BOTANY.

Bog-Trotting for Orchids[1] is the title of a popular book dealing with the swamp flora of the Hoosac Valley. It gives a pleasant, diary-like account of the author's rambles for three seasons, in the course of which are given descriptions and other information regarding her various finds. An appendix of 44 pages presents a systematic account of the genera and species of New England Orchidaceæ, and there is an admirably full index. The illustrations are photographic, many of them excellent; some are colored, not always to advantage, and a considerable proportion are of landscape views or objects other than orchids. As one reads the rambling narrative one cannot but sympathize with the writer's enthusiasm, and is sure to get refreshing whiffs of out-door air. Despite occasional inaccuracies, showing the lack of expert revision, and the inclusion of considerable material of rather more personal than general interest, the book has the charm and value which belong to a faithful record of first-hand impressions, and which will doubtless render it an inspiring help to many amateurs.

F. L. S.

Agriculture for Schools.—Two interesting attempts to meet the demand for instruction in matters of special importance to farming communities, are found in a handbook of exercises edited by Prof. Hays[2] and an elementary text-book by Profs. Burkett, Stevens and Hill.[3]

The hand-book consists of 237 exercises of an eminently practical nature as may be judged from the following sample titles taken at random: Food stored in seeds; Making maps of public roads; Transpiration of water by plants; Teeth of domestic animals; Bowline knot; Sharpening pocket knives; Classes of chickens; Classi-

[1] Niles, Grace Graylock.—*Bog-Trotting for Orchids.* New York, C. P. Putnam's Sons, 1904. xiv + 310 pp., 72 pls.

[2] Hays, Willet M.—*Rural School Agriculture.* Bulletin No. 1. *Exercises in Agriculture and Housekeeping for Rural Schools.* St. Anthony Park, Minn., Department of Agriculture, University of Minnesota, 1903. 12mo, viii + 196, 79 figs.

[3] Burkett, C. W., Stevens, F. L., and Hill, D. H.—*Agriculture for Beginners.* Boston, Ginn & Company, 1903. 12mo, xii + 267, 215 figs.

fication of soils; Crossing corn; Emergencies; Removing ink from white goods; To make liquid yeast; Chicory in coffee; Cash account; Tent caterpillars; Planting trees; Farm gate lesson; Sewed seam; Overhand patch; Three-cornered darn; Cleft grafting. These exercises are arranged somewhat in the order of difficulty and in related groups, but the extent to which they shall elucidate principles or develop general ideas must very largely depend upon the teacher. If skilfully incorporated with other work and their bearings broadly discussed many of these exercises would have real educational value in fitting pupils to meet intelligently the actual problems of rural life.

The text-book proceeds in a more orderly way, establishing general principles and showing their application to problems of soil, culture, protection, selection, stock-raising and dairying. Suggestions for profitable observations or experiments are freely introduced. The illustrations are of unusual excellence, and the style clear and direct. Such a book cannot fail to advance the best interests of practical education in much needed directions. Both books might well be used together.

Frederick LeRoy Sargent.

Notes.— André Michaux's "Travels into Kentucky," F. A. Michaux's "Travels west of Alleghany mountains," and Harris's "Journal of a tour northwest of Alleghany mountains," are republished, with annotations, by Thwaites as vol. 3 of his series of *Early Western Travels*, issued by the Arthur H. Clark Company, of Cleveland. It is regrettable that the volume is not provided with an index making its wealth of detailed information available.

A small list of arctic plants is given in Schrader's "Reconnaissance in Northern Alaska," published as *Professional Paper No. 20* of the U. S. Geological Survey.

A polyglot suggestion of amendments to the Paris code of botanical nomenclature, addressed to the Vienna Congress of 1905, has been published by the botanists of the Gray Herbarium, the Cryptogamic Herbarium and the Botanical Museum of Harvard University, under date of June 9.

The annual species commonly referred to Polypteris have been segregated under Rafinesque's generic name Othake, by Bush, in vol. 14, no. 6, of the *Transactions of the Academy of Science of St. Louis*.

Three new exotic orchids ascribed to Rolfe are described by Ames in *Proceedings of the Biological Society of Washington*, of June 9.

Two new Jamaican species of Polypodium are described by Maxon in no. 1374 of *Proceedings of the U. S. National Museum.*

Blakeslee has an interesting note on the sexuality of Rhizopus in *Science* of June 3.

A paper on vitality and germination of seeds, by Duvel, forms *Bulletin no. 58* of the Bureau of Plant Industry of the U. S. Department of Agriculture.

A résumé of ecological work in 1903 is given by Cowles in *Science* of June 10th.

A healthy sane tone pervades an article by Holt on the value of field and herbarium work in high school botany, published in *School Science* for June.

Ecological experiments on *Rumex Acetosella* are described by Transeau in *Science* of June 3.

A critical study of Lepidium is being published by Schinz in the *Bulletin de l'Herbier Boissier.*

A popular account of the native Papaw is given by Viola McCohn in *Country Life in America* for July.

A further list of Eastern species of Cratægus is published by Ashe, under date of June 15, in vol. 20, no. 2, of the *Journal of the Elisha Mitchell Scientific Society.*

Professor Bessey calls attention, in *Science* of June 24, to the early falling of the aberrant lowermost leaves of *Acer Negundo* each year.

The July number of *Arboriculture*, printed on paper made from the wood of Catalpa, contains data as to the availability of this wood for paper purposes.

A review of Californian Polemoniaceæ, by Jessie Milliken, forms vol. 2, no. 1, of the *University of California Publications, Botany*, issued May 10.

Heft 19 of Engler's "Pflanzenreich," is devoted to Betulaceæ, by Winkler.

An account of *Persea gratissima* as cultivated in Florida is published by Rolfs as *Bulletin no. 61* of the Bureau of Plant Industry of the U. S. Department of Agriculture.

A developmental account of Juncaceæ is contributed by Laurent to no. 2–3 of the current volume of *Annales des Sciences Naturelles, Botanique.*

Anatomico-ecological studies of Tillandsia are published by Mez in Vol. 40, Heft 2, of *Jahrbücher für wissenschaftliche Botanik.*

The Germination of Amaryllidaceæ is considered by Worsley in the *Journal of the Royal Horticultural Society* of May.

A reprint of Bradbury's "Travels in the Interior of America," second edition, London, 1819, which forms vol. 5 of Thwaites' "Early Western Travels," contains a list of plants collected about St. Louis and on the Missouri River.

Under the title "Contributions to our knowledge of the flora of the Rocky Mountains," Aven Nelson has collected as a thesis for the Doctor's degree his more important papers published in various journals between 1898 and 1904.

The opening fascicle of vol. 5 of Urban's "Symbolæ Antillanæ" contains revisions of Smilax (by Schulz), Celastraceæ (by Urban), and Sapotaceæ, in part (by Pierre and Urban).

Under the heading "Trabajos de la Oficina de Historia Natural," the Colombian government is publishing a series of papers on the botany of that country, by Cortes.

The first fascicle of vol. 2 of Arechavaleta's "Flora Uraguayana," has been issued by the Museo Nacional de Montevideo, as a part of its *Anales.*

Volume 2 of Wood's "Natal Plants" is completed by the issuance of part 4, dealing with grasses.

No. 28 of the new series of "Contributions from the Gray Herbarium of Harvard University," forming vol. 40, no. 1, of the *Proceedings of the American Academy of Arts and Sciences*, and issued on July 18th, contains the following papers: Robinson and Greenman, Revision of the Genus Sabazia, Revision of the Mexican and Central American Species of Trixis, and Revision of the Mexican and Central American Species of Hieracium; Fernald, Synopsis of the Mexican and Central American Species of Alnus, and Some New Species of Mexican and Nicaraguan Dicotyledons; and Greenman, Diagnoses and Synonymy of Mexican and Central American Spermatophytes.

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